Lower Middle Miocene Retrogradational Play
MM4 R1, #1921
Gyroidina "K" through *Amphistegina* "B"

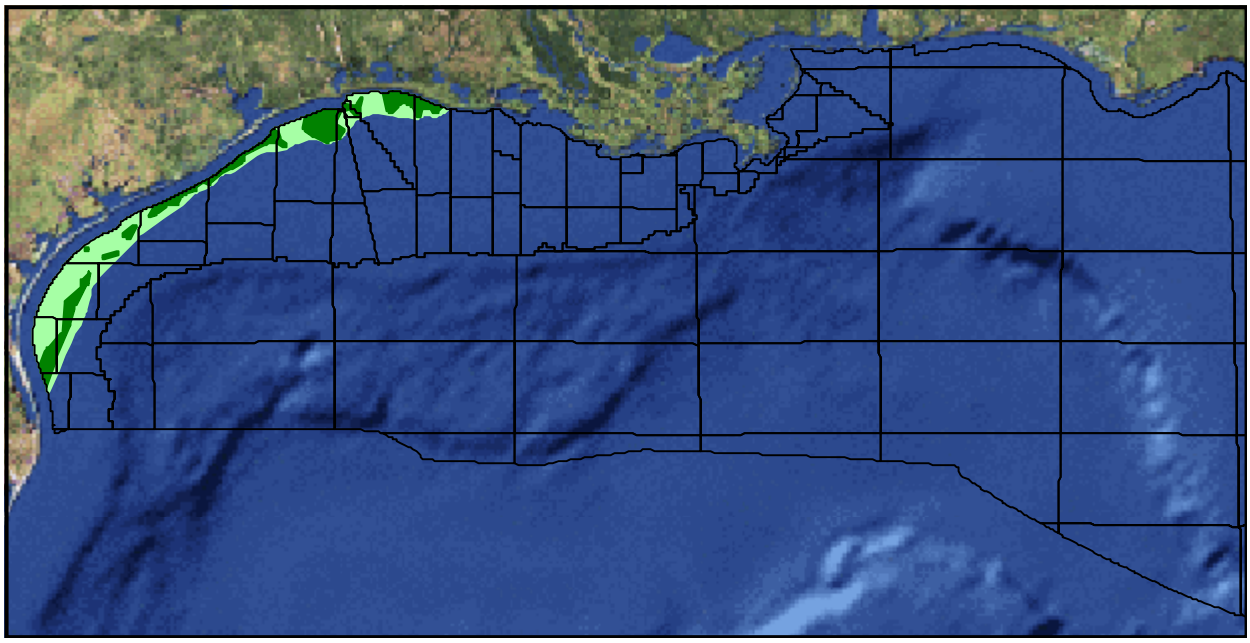

Figure 295. MM4 R1 map showing location of play. Play limit shown in light green; hydrocarbon limit shown in dark green.

Overview

The Lower Middle Miocene Retrogradational Play (MM4 R1) contains reserves of 1,191.774 Bcfg and 35.646 MMbo (247.705 MMBOE) in 90 sands in 45 fields. The play extends continuously across the modern GOM shelf from the South Padre Island to East Cameron Area (Figure 295).

Description

MM4 R1 is defined by (1) a retrogradational depositional style representing the reworking of sediments by major marine transgressions and (2) the MM-1, MM-2, MM-3, and MM-4 Chronozones, the tops of which are defined by the *Gyroidina* "K", *Cristellaria* 54/*Eponides* 14, *Robulus* 43, and *Amphistegina* "B" biozones, respectively (Figure 8).

MM4 R1 extends continuously across the modern GOM shelf from the South Padre Island Area offshore Texas to the East Cameron Area offshore Louisiana (Figure 295). Hydrocarbons have been encountered over most of the play area. However, no productive sands are associated with the *Gyroidina* "K" (MM-1) biozone.

Depositional systems included the North Padre Delta System in the southern Texas area and the Calcasieu Delta System along the Texas-Louisiana border (Galloway et al., 1986). The MM4 retrogradational facies covers a much larger geographic area than the older upper lower Miocene (LM4) retrogradational facies. The larger area of the MM4 retrogradational facies is undoubtedly related to the four significant flooding events that comprise the MM4 Chronozone sequence and to the basinward progradation of the Calcasieu Delta System that provided significantly more sand deposits for reworking during the MM4 marine transgressions.

Play Limits

Updip, the play extends onshore into Texas and Louisiana. To the southwest, the play continues onshore into Texas. To the east, the play continues onshore into Louisiana. Downdip, MM4 R1 deposits grade into the sediments of either the Lower Middle

Miocene Aggradational Play (MM4 A1) or the Lower Middle Miocene Progradational Play (MM4 P1).

Depositional Style

Retrogradational sediments that formed as reworked shelf sediments, including channel/levee complexes, crevasse splays, distributary mouth bars, shelf blanket deposits, and delta-fringe sands, characterize MM4 R1 depositionally. These thin, reworked sands exhibit an upward-fining, back-stepping log signature and are overlain by a thick shale sequence associated with the *Gyroidina* "K," *Cristellaria* 54/*Eponides* 14, *Robulus* 43, or *Amphistegina* "B" flooding event. The MM4 retrogradational interval varies from approximately 100 to more than 2,600 ft in thickness, with net sand thicknesses as much as approximately 300 ft. Individual MM4 R1 sands are, at the most, a few tens of feet thick and are interbedded with shales of the same thickness. The overlying shales associated with the *Amphistegina* "B" flooding event are over 1,000 ft thick and mark the transition to the younger middle middle Miocene (MM7) deposits.

Productive MM4 R1 sequences are associated with three distinct marine transgressions. They are, from oldest to youngest, the *Cristellaria* 54/*Eponides* 14, which occurs in the Brazos and Galveston Areas; the *Robulus* 43, which occurs from the Mustang Island to West Cameron Area; and the *Amphistegina* "B," which occurs from the North Padre Island to East Cameron Area. The lateral expansion of these sequences through MM4 time reflects not only the magnitude of the marine transgression but also the increased sand influx from the deltas, in particular ancestral Mississippi River Deltas, as they were becoming more dominant.

Structural Style

The majority of fields in MM4 R1 are structurally associated with normal faults and anticlines. Other less common structures are associated with growth fault anticlines, and salt or shale diapirs with traps on the flanks of the diapir or in sediment drape over the diapir.

Quantitative Attributes

On the basis of reserves calculations, MM4 R1 contains 86% gas and 14% oil. The 90 sands in the play comprise 183 reservoirs, of which 161 are non-associated gas, 9 are undersaturated oil, and 13 are saturated oil. All reserves are proved and estimated to be 1,191.774 Bcfg and 35.646 MMbo (247.705 MMBOE) (Table 141). These reserves account for just over 12% of the reserves for the MM4 Chronozone.

	No. of Sands	Oil (MMbbl)	Gas (Bcf)	BOE (MMbbl)
Proved	90	35.646	1,191.774	247.705
Cum. production	81	30.048	967.124	202.134
Remaining proved	60	5.598	224.650	45.572
Unproved	0	0.000	0.000	0.000

Table 141. MM4 R1 reserves and cumulative production.

Cumulative production from MM4 R1 totals 967.124 Bcfg and 30.048 MMbo (202.134 MMBOE) from 81 sands in 42 fields. This production accounts for 12% of the MM4 Chronozone's total production. Remaining proved reserves in the play are 224.650 Bcfg and 5.598 MMbo (45.572 MMBOE) in 60 sands in 38 fields.

Table 142 summarizes that water depths of the fields in MM4 R1 range from 31-190 ft, and play interval discovery depths vary from 3,835-13,187 ft, subsea. Additionally, porosity and water saturation range from 21-33% and 16-56%, respectively.

90 Sands	Min	Mean	Max
Water depth (ft)	31	68	190
Subsea depth (ft)	3,835	7,002	13,187
Reservoirs per sand	1	2	9
Porosity	21%	28%	33%
Water saturation	16%	31%	56%

Table 142. MM4 R1 sand attributes. Values are volume-weighted averages of individual reservoir attributes.

Exploration History

MM4 R1 has a 50-year history of discoveries (Figure 296). The first sand in the play was discovered in 1949 in the West Cameron 45 Field. The maximum number of sands discovered in any year occurred in 1979 with eight sands from three fields. However, the maximum yearly total reserves of 64.606 MMBOE were added in 1974 from six sands in two fields. Moreover, the discoveries from just two years, 1970 and 1974, account for 41% of the play's total reserves.

The largest sand in the play was discovered in 1970 in the East Cameron 33 Field and contains an estimated 34.342 MMBOE (Figure 297). Only two other sands in the play contain more than 20

MMBOE. The mean sand size for the play is 2.752 MMBOE. Since the first Atlas database cutoff of January 1, 1995, four sands have been discovered, the largest of which is estimated to contain 2.854 MMBOE.

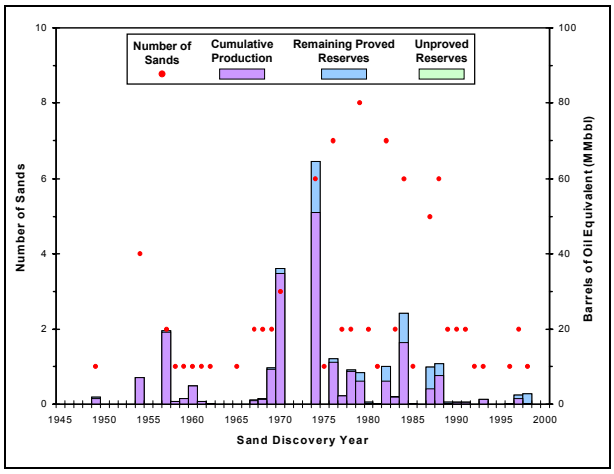

Figure 296. MM4 R1 exploration history graph showing reserves and number of sands discovered by year.

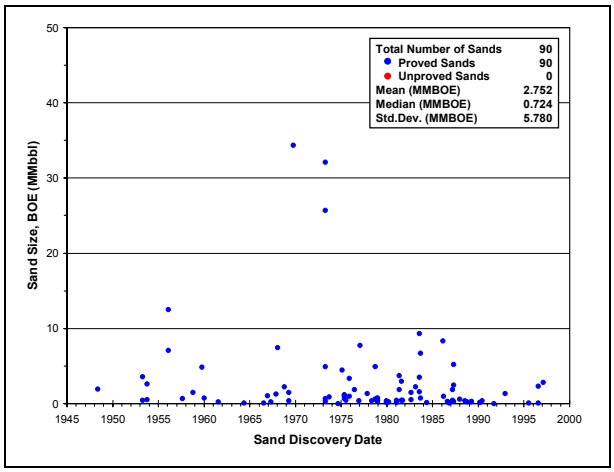

Figure 297. MM4 R1 sand discovery graph showing the size of sands discovered by year.

Production History

MM4 R1 has a 45-year history of production (Figure 298). Production from the play began in 1954, a five-year lag from the first discovery in the play. Oil production, aside from minor fluctuations, increased fairly steady until 1984, when it peaked. For the next 13 years, oil production generally declined, but in 1998 it rose by over 70% from the previous year's level. Gas production generally increased until peaking in 1974, and then leveled off at a somewhat lower value. However, in 1998 gas production increased by over 60% from the previous year's level.

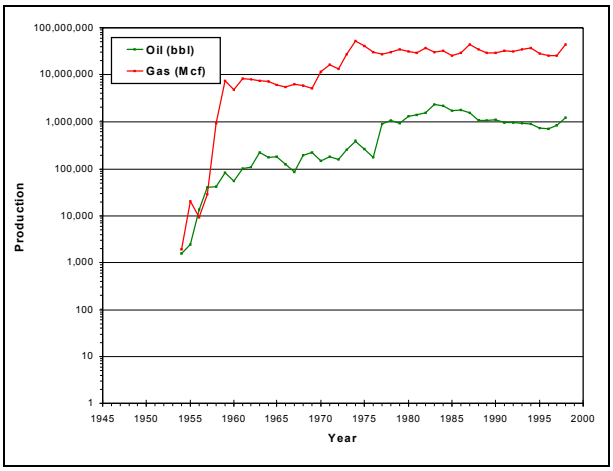

Figure 298. MM4 R1 production graph showing oil and gas production by year.